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Pain, impaired functioning, poor satisfaction and diminished health status eight years following perilunate (fracture) dislocations

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ABSTRACT

Purpose: Perilunate (fracture) dislocations are rare injuries and diminished functional outcomes are reported. However, Patient Reported Outcomes (PROs) following these injuries are rarely described. The aim of this study was to investigate the long-term impact of perilunate (fracture) dislocations using a range of measures, including pain, function, and quality of life.

Materials and Methods: This cross-sectional study was conducted from January 2016 until March 2016. Eleven patients who had suffered from perilunate (fracture) dislocations between August 1996 and January 2014 were matched on age and gender with 22 healthy controls. Functional outcome included range of motion and grip strength measurements. The Patient Reported Outcomes included: Patient Reported Wrist Evaluation, Disability of Arm, Shoulder and Hand questionnaire, Michigan Hand Questionnaire and the Short Form-36.

Results: The 11 patients that were included (9 males) had a median age at injury of 38 years (IQR 33; 54) and median follow up of 97 months (IQR 84-193). Flexion/extension (mean difference −60°, 95% CI −76, −43, $p < 0.001$) and ulnar/radial deviation (mean difference −28°, 95% CI −38, −18, $p < 0.001$) were significantly diminished in patients following perilunate (fracture) dislocations. Grip strength was not affected. The patients experienced significantly more pain as assessed on all pain subscales. Physical functioning was significantly worse in the group with perilunate (fracture) dislocations as assessed on all function subscales, except the PRWE function score and the subscale physical functioning of the Short Form-36. Satisfaction as measured with the Michigan Hand Questionnaire satisfaction subscale (mean difference −36, 95% CI −57, −16, $p = 0.002$) was also reported poorer. No difference was found regarding work participation.

Conclusions: A perilunate (fracture) dislocation has a significant impact on everyday life, as patients experience diminished range of motion, pain, diminished physical functioning, diminished satisfaction and report lower general health status than healthy controls. However, no consequences for work participation were found in this study. Level of evidence 3.

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Perilunate dislocation; hand; wrist; outcome; rehabilitation

➤ IMPLICATIONS FOR REHABILITATION

- Flexion/extension and ulnar/radial deviation remains limited following perilunate (fracture) dislocations.
- Grip strength is not diminished in patients with perilunate (fracture) dislocations.
- Pain, restrictions in physical functioning, diminished satisfaction and lower general health status are likely to be present following perilunate (fracture) dislocations.
- If conservative treatment including pain medication and rehabilitation strategies do not relief pain following perilunate (fracture) dislocations, surgical treatment options such as wrist denervation or arthrodesis should be considered.

Introduction

Perilunate dislocations and perilunate fracture dislocations (PLD/PLFDs) are rare injuries of the wrist and comprise only 7% of all carpal injuries [1–5]. PLFDs occur more frequently than PLDs (ratio 2:1), in which the scaphoid bone is most often fractured [6]. Most PLD/PLFDs are seen following injury with high energy transmission. Twenty percent of all PLD/PLFDs are associated with polytrauma [7]. Diminished range of motion of 59–82% and grip strength measurements ranging from 59–87% in comparison to the uninjured wrist were reported 6-months to 5 years following PLD/PLFDs [3,8–11]. In addition, poor outcomes regarding PROs have been reported with Disability of Arm Shoulder Hand (DASH) scores ranging from 14–40 and Patient Rated Wrist Evaluation (PRWE) scores ranging from 13–41 [3,8–13]. Complicated PLD/PLFD is thought to result in poorer outcomes due to extensive soft tissue damage [7]. Late identification of PLD/PLFDs ligament

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ruptures or accompanying fractures also lead to worse outcomes [2,7,14–16]. Bone necrosis and posttraumatic arthritis is known to develop following this injury [17]. Prevalence of posttraumatic arthritis following PLD/PLFDs of up to 56% has been reported 6 years post-injury [7]. The development of posttraumatic arthritis of the wrist increases with direct or indirect impact load on the joint, soft tissue contusion, joint dislocation, and intra-articular fractures (most often scaphoid bone fractures) [18–20]. Posttraumatic arthritis can result in severe functional impairment with regard to range of motion and grip strength [18].

In order to treat and guide patients with PLD/PLFDs optimally, it is important to have knowledge on specific outcome measurements, such as grip strength and active range of motion, as well as Patient Reported Outcomes (PROs). Loss of grip strength, limited range of motion of the wrist and pain are common findings after PLD/PLFDs and lead to impaired functioning in daily life [13,15,16]. Impairment has been described to such extent that patients did not return to work or had to change to a less strenuous occupation [10]. In case of PLD/PLFDs, some studies reported on PROs [3,8–13]. The Cooney rating system or Mayo Wrist Score are often reported, which are aggregated scores of pain, functional status, range of motion and grip strength [4,13,21]. Although both systems are easy to use, they are not validated and the rating does not differentiate between functional outcome and PROs. There is a need for more insight in long term outcomes captured in functional outcomes and PROs in this working and mostly active population. We believe this may help to develop more targeted surgical and rehabilitation treatment strategies minimizing long-term consequences of this injury. Furthermore, information regarding pain, satisfaction, daily and general functioning is needed to inform patients on their long-term outcomes. However, these measures are scarcely reported in literature. Furthermore, results are mostly not compared with matched controls, which could hamper the interpretation of the outcomes.

The purpose of this study was to gain better insight in the specific limitations in functioning on the long-term following PLD/PLFDs. The aims of this study were to assess functional outcomes and PROs of patients following PLD/PLFDs and compare the outcomes with results of matched control patients.

Materials and methods

Study population

This cross-sectional study was performed at a level 1 traumacenter and was approved by the local medical ethics committee (METC NL52111.042.15). Patients and controls provided written informed consent before entering the study. All patients received an invitation for a single visit to the hospital and received a gift voucher and compensation for travel expenses after having participated in the study.

Hospital records of patients treated for a PLD/PLFD between August 1996 and January 2014 were retrieved. Patients who consented for participation were measured between January 2016 and March 2016. Inclusion criteria were: minimal follow up duration of 2 years, mental competence, living in the Netherlands and having sufficient control of the native language in order to answer the questionnaires. Exclusion criteria were: co-morbidity that might influence the outcomes, such as neurological or rheumatic disorders influencing arm function. Since surgery is the advised treatment option for PLD/PLFD patients, those with contra-indications for surgical treatment at the time of injury were excluded, because worse outcomes can be expected without surgical treatment [22]. The controls were individually matched on age (± approximately 2 years) and gender. Every PLD/PLFD patient was matched with two controls. Controls with different occupations and various educational levels were recruited among the hospital personnel and acquaintances of the researchers.

Functional outcomes

The functional outcomes of the PLD/PLFD group were obtained by a certified hand therapist and the functional outcomes of the matched controls were obtained by one of the authors. For measurements of all functional outcomes (range of motion and grip strength measurements) patients were positioned sitting positioned sitting at a table, with hips and knees flexed 90˚. In addition, elbows were positioned on the table and flexed in 90˚ with wrists in neutral position.

The flexion/extension, ulnar/radial deviation and supination/pronation range of motion were measured using a digital protractor of Biometrics LTD and E-Link® software and expressed in degrees and in percentage of the uninjured side.

Grip strength, sustained grip strength and key pinch strength were measured using a digital Jamar dynamometer and a pinch meter using Biometrics LTD and E-Link® software. Grip strength and key pinch strength were presented in kilograms and percentage of the uninjured side, and were derived from the maximum peak strength sustained during at least 2 s. The mean of three performances was presented. Grip strength of less than 75% compared to the uninjured side was considered as an adverse outcome [23]. For assessing sustained grip strength, patients were asked to grip as hard as they could using the dynamometer during a 30 s period. Sustained grip strength is the average grip strength in kilograms, computed over the last 18 s of this 30-s period. In all patients first the arcs of motion measurements, then grip strength measurements were performed, alternating between both hands.

Patient reported outcomes

PROs were measured using four questionnaires involving pain scores, health related quality of life, satisfaction and specific hand and wrist functioning.

DASH

The Disability of Arm, Shoulder and Hand questionnaire (DASH) measures upper extremity performance in 30 activities of daily living and two optional scales of four questions each measuring work and leisure time participation. Scores range from 0 to 100. A higher score indicates more disability or severity of complaints. DASH has a good validity for symptoms and function of the upper limb [14]. The Dutch version (DASH-DLV) has recently been validated and combines outcome measures such as pain, function or patient satisfaction in a unidimensional trait [24,25].

PRWE

The Patient Rated Wrist Evaluation questionnaire (PRWE) rates a patients' level of both wrist pain and disability. The pain subscale contains five questions, which are rated from 0 (no pain) to 10 (unbearable pain). The function subscale contains ten questions, which are divided into two sections concerning specific activities and usual activities. For each section the minimum score is 0 (no disability) and the maximum score is 50 (worst possible disability) [14]. The questionnaire has a good validity for symptoms and function of the wrist [26]. The translated version of the PRWE (PRWE-NL) has been validated and confirmatory factor analysis

Table 1. Patient characteristics of the PLD/PLFD group ($n = 11$) and the matched control group ($n = 22$).

	PLD/PLFD group	Control group
Male : Female	9 : 2	9 : 2
PLD : PLFD	4 : 7	–
Dominant side Left : Right	1 : 10	0 : 22
	Median (IQR)	**Median (IQR)**
Age at time of injury (years)	38.0 (33.0;54.0)	–
Age at follow-up (years)	48.0 (40.0;63.0)	48.5 (39.5;64.3)
Delay surgery (days)	0 (0;1)	–
Follow-up (months)	97 (84;193)	–
	n	***n***
Dominant side injured	4	–
Surgical approach		–
dorsal	2	
volar	5	
combined approach	1	
percutaneous	3	
Surgical procedure		–
K-wire	3	
Screw	1	
K-wire and screw	3	
K-wire and fragment fixation system	1	
Screw and external fixation	1	
K-wire, screw and external fixation	2	
Secondary surgery	4	–
arthrodesis	2	
Rehabilitation program	7	–

n: number of participants; IQR: interquartile range 25th - 75th quartile; PLD: perilunate dislocation; PLFD: perilunate fracture dislocation; K-wire: kirschner wire.

revealed that this translated PRO should be considered measuring a unidimensional trait, without using subscale scores [27,28].

MHQ

The Michigan Hand Outcome Questionnaire (MHQ) rates hand-specific outcomes and contains six subscales: general hand function, daily functioning, work, pain, esthetics and patient satisfaction with hand function. The scale score is the sum of the answer to each question and ranges from 0 to 100. A higher score in the pain scale indicates more pain. For the other five scales, higher scores imply a better hand performance [29]. The MHQ is a reliable and valid questionnaire for measuring hand outcome in patients with varying hand problems [29,30]. The MHQ has not yet been validated in the Dutch translated version.

SF-36

The Short Form Health Survey (SF-36) contains 36 questions about a patients' health status. Nine subscales are distinguished: physical functioning, social functioning, role limitation physical, role limitation social, mental health, vitality, pain, general health and health change. Each subscale ranges from 0 (maximum disability/pain) to 100 (no disability/pain) [31]. Jenkinson et al. have shown that the validity of this questionnaire is sufficient for groups reporting varying extents of illness-health [31]. In addition, it has been validated in the Dutch language [32].

Statistical analysis

Paired samples T tests were used to determine statistical differences between functional outcome of injured and uninjured wrist. Welch tests were used to determine statistical differences between functional outcome or PROs between the PLD/PLFDs group and the matched control group. Because of multitesting, a p values <0.01 was considered statistically significant.

Results

Study population

PLD/PLFD group

A total of 24 patients with PLD/PLFDs were retrieved from the hospital records. Three patients were excluded based on insufficient control of the Dutch language or dementia. Two patients could not be reached due to outdated contact information. Eight patients refused to participate. Finally, a total of 11 patients were included (9 males) with median age at injury of 38 years (IQR 33; 54). Median follow up time was 97 months (IQR 84–193) (Table 1). Five patients had sustained a fracture of the scaphoid. The capitate was fractured in one patient and the ulnar styloid was fractured in two patients. Six patients had transient median nerve neuropraxia. All PLD/PLFDs were surgically treated within five days following the injury. Four patients underwent secondary surgery because of re-dislocation, three within nine days after initial surgery, one at two years after initial surgery. Approximately two years after the injury, one patient underwent a four-corner arthrodesis and another patient underwent a complete wrist arthrodesis. Seven patients received specific rehabilitation programs for the PLD/PLFD, while four did not (Table 1).

Matched control group

Twenty-two control patients were matched with the eleven included PLD/PLFD patients: no significant differences were found in age or gender between the groups (Table 1).

Functional outcomes

Within patients with PLD/PLFD flexion/extension and ulnar/radial deviation were significantly worse in the injured compared to the uninjured wrist (mean difference -54°, 95% CI -77, -31, $p < 0.001$ and mean difference -29°, 95% CI -37, -20, $p < 0.001$), even when excluding patients with an arthrodesis (Table 2). For

Table 2. Functional outcome between injured and uninjured wrist for PLD/PLFD patients.

	Injured wrist Mean (SD)	Uninjured wrist Mean (SD)	Mean difference (SD)	95% CI	*p*-value
All patients					
Range of motion (°)					
Flexion/extension	90 (27)	144 (16)	− 54 (34)	−77; −31	<0.001
Ulnar/radial deviation	33 (14)	61 (10)	−29 (13)	−37; −20	<0.001
Supination/pronation	155 (12)	162 (9)	−8 (9)	−14; −2	0.016
Grip strength measurements (kg)					
Grip strength	35.3 (16.0)	48.0 (13.0)	−12.7 (10.4)	−19.7; −6.0	0.002
Sustained grip strength	22.3 (11.9)	30.0 (10.2)	−7.6 (9.8)	−14.2; −1.0	0.027
Key pinch strength	8.5 (1.7)	9.2 (2.4)	−.7 (1.6)	−1.8; .3	0.157
Patients without arthrodesis	**(*n* = 9)**	**(*n* = 9)**			
Range of motion (°)					
Flexion/extension	97 (23)	142 (16)	−45 (29)	−67; −22	0.002
Ulnar/radial deviation	35 (10)	62 (10)	−27 (12)	−36; −18	<0.001
Supination/pronation	157 (10)	163 (10)	−6 (7)	−11; −1	0.035
Grip strength measurements (kg)					
Grip strength	33.9 (17.5)	45.6 (12.8)	−11.7 (10.9)	−20.1; −3.3	0.012
Sustained grip strength	22.1 (13.3)	28.9 (9.7)	−6.7 (9.3)	−14.0; .4	0.060
Key pinch strength	8.7 (1.8)	9.1 (2.4)	−.5 (1.5)	−1.6; .7	0.365

Results of Paired samples T test.
n: number of participants; SD: standard deviation; 95% CI: 95% confidence interval of the difference; kg: kilogram.

Table 3. Functional outcome for PLD/PLFD patients and matched controls.

	PLD/PLFD group (*n* = 11) Mean (SD)	Control group (*n* = 22) Mean (SD)	Mean difference (SE)	95% CI	*p*-value
All patients					
Range of motion (°)					
Flexion/extension	90 (27)	150 (20)	−60 (9)	−76; −43	<0.001
Ulnar/radial deviation	33 (14)	61 (12)	−28 (5)	−38; −18	<0.001
Supination/pronation	154 (12)	164 (14)	−10 (5)	−19; 0	0.055
Grip strength measurements (kg)					
Grip strength	35.3 (16.0)	45.1 (14.3)	−9.8 (5.7)	−22; 1	0.103
Sustained grip strength	22.3 (11.9)	29.6 (10.6)	−7.3 (4.2)	−16.2; 1.6	0.102
Key pinch strength	8.5 (1.7)	9.0 (2.4)	−.6 (.7)	−2.1; 1.0	0.455
Patients without arthrodesis	**(*n* = 9)**	**(*n* = 18)**			
Range of motion (°)					
Flexion/extension	97 (23)	149 (18)	−52 (8)	−70; −33	<0.001
Ulnar/radial deviation	35 (10)	60 (12)	−25 (4)	−34; −16	<0.001
Supination/pronatio	157 (12)	163 (12)	−7 (4)	−16; 1.9	0.118
Grip strength measurements (kg)					
Grip strength	33.9 (17.5)	44.3 (15.3)	−10.4 (6.9)	−25.1; 4.3	0.151
Sustained grip strength	22.1 (13.3)	28.7 (11.3)	−6.6 (5.2)	−17.7; 4.5	0.223
Key pinch strength	8.7 (1.8)	8.8 (2.5)	−.1 (.8)	−1.9; 1.6	0.881

Results of Welch test.
n: number of participants; SD: standard deviation; SE: standard error; 95% CI: 95% confidence interval of the difference; kg: kilogram.

grip strength measurements in comparison to the uninjured wrist, only grip strength (mean difference −12.7 kg, 95% CI −19.7, −6, $p = 0.002$) was significantly worse in the injured wrist (Table 2). Patients without arthrodesis did not have a significant difference in grip strength between the injured and uninjured wrist. Grip strength of the patients' injured side was median 80% of the uninjured side. Four patients had grip strength <75% of the uninjured side.

Flexion/extension (mean difference −60°, 95% CI −76, −43, $p < 0.001$) and ulnar/radial deviation (mean difference −28°, 95% CI −38, −18, $p < 0.001$) were significantly diminished in patients with PLD/PLFD in comparison to matched controls. When excluding patients with arthrodesis, flexion/extension and ulnar/radial deviation remained significantly diminished in patients with PLD/PLFDs (Table 3). With regard to all grip strength measurements, no significant differences were present between patients with PLD/PLFDs and matched controls (Table 3).

Patient reported outcomes

Pain. Pain was significantly higher in the PLD/PLFD group compared to the control group as measured on all pain subscales (Table 4).

Physical functioning. Hand function, daily functioning and general physical functioning were significantly worse in the PLD/PLFD group compared to the control group as measured with the total DASH score (mean difference 19, 95% CI 10, 28, $p = 0.010$), total PRWE score (mean difference 30, 95% CI 0, 38, $p = 0.001$, MHQ subscale general functioning scale (mean difference −35, 95% CI −46, −24, $p = <0.001$), MHQ subscale activities general life (mean difference −16, 95% CI −25, −7, $p = 0.003$). The PRWE function score and the SF36 physical functioning subscale was not significantly different between patients with PLD/PLFDs and matched controls (Table 4).

Table 4. Patient reported outcomes (PROs) for PLD/PLFD patients and matched controls.

PROs	PLD/PLFD group ($n = 11$) Mean (SD)	Control group ($n = 22$) Mean (SD)	Mean difference (SE)	95% CI	p-value
DASH	22 (20)	3 (6)	19 (6)	6; 33	0.010
PRWE					
Pain	19 (14)	1 (2)	19 (4)	9; 28	0.001
Function	19 (28)	0 (1)	19 (8)	0; 38	0.047
Total	31 (22)	1 (3)	30 (7)	15; 45	0.001
MHQ					
General function	59 (16)	94 (9)	−35 (5)	−46; −24	<0.001
Activities general life	84 (13)	99 (2)	−16 (4)	−25; −7	0.003
Work	89 (20)	100 (0)	−11 (6)	−24; 2	0.095
Pain	71 (26)	98 (4)	−28 (8)	−45; −10	0.006
Esthetics	91 (11)	97 (11)	−6 (4)	−14; 3	0.170
Satisfaction	63 (30)	99 (2)	−36 (9)	−57; −16	0.002
Total	76 (15)	98 (3)	−22 (5)	−32; −12	0.001
SF-36					
Physical functioning	86 (9)	93 (15)	−6 (4)	−16; 4	0.209
Social functioning	80 (31)	95 (12)	−15 (10)	−36; 6	0.138
Role model physical problem	61 (41)	88 (30)	−26 (14)	−56; 3	0.078
Role model emotional problem	85 (35)	95 (21)	−11 (11)	−35; 14	0.366
Mental health	75 (19)	89 (11)	−14 (6)	−27; 0	0.046
Vitality	67 (21)	82 (15)	−15 (7)	−30; 0	0.051
Pain	68 (22)	90 (14)	−22 (7)	−38; −7	0.008
General health experience	67 (11)	78 (14)	−11 (4)	−20; −1	0.019
Health change	45 (10)	51 (14)	−7 (4)	−16; 3	0.139

Results of Welch test.
n: number of participants; SD: standard deviation; SE: standard error; 95% CI: 95% confidence interval of the difference.

Satisfaction. Patients were less satisfied with their wrist compared to the controls (mean difference MHQ subscale satisfaction −36, 95% CI −57, −16, $p = 0.002$).

General health status. Although not significant, patients did seem to experience an impact on overall health status, as can be retrieved from the SF36 subscale general health experience (mean difference −11, 95% CI −20, −1, $p = 0.019$) (Table 4).

Work. Two of the nine working PLD/PLFD patients had to alter their occupation following injury because physical demands for the injured side were too high in the original occupation.

Discussion

On average 8 years after they sustained the injury, PLD/PLFD patients experienced a decreased range of motion of the affected wrist and a substantial amount of pain. They were less satisfied and reported diminished daily and general physical functioning. The significant disability of the PLD/PLFD patients, which has previously been described using mainly functional outcomes, was confirmed in the current research. Especially the application of a wide variety of PROs provided new insight in the impact of PLD/PLFDs on everyday life regarding pain, physical functioning, satisfaction and health status patients experience following PLD/PLFDs.

Functional outcomes

Range of motion

Diminished flexion, extension, ulnar and radial deviation of the wrist after PLD/PLFD were previously described [3,8,11,13,33]. We hypothesize that the decrease in the range of motion may be caused by posttraumatic arthritis or ligamentous injury, even when adequate surgical treatment has been provided. However, our study cannot confirm this, because no radiographs were taken at follow-up. Pro- and supination of the wrist were not affected, probably because these movements are regulated mostly in the elbow and the distal radio-ulnar joint [34].

Grip strength

Grip strength measurements were comparable in patients and controls, although a significant difference was found within the PLD/PLFD patients between the injured and uninjured side of which four patients had grip strength measurements of <75% of the uninjured wrist. An explanation could be overcompensation of the uninjured hand resulting in relatively high grip strength and sustained grip strength in that hand. These findings imply that the injured side needs extra attention to increase strength, for example by applying specific training programs. Compared to literature our results reflect a reasonably good outcome [9,23]. Capo et al. reported grip strength following PLD/PLFDs of only 59% in comparison to the unaffected side [8]. The substantial decrease in grip strength was probably caused by additional upper limb fractures in some of the PLD/PLFD patients in that study. Grip strength is regulated mainly by the strength of a chain of muscles like forearm muscles, biceps and triceps muscles, which are not affected in PLD/PLFD patients [35].

Patient reported outcomes

Pain. All pain scales showed that patients experienced more pain than the matched controls. Clinicians treating these patients should therefore realize that pain is a considerable problem in PLD/PLFD patients and should treat these patients accordingly, e.g., by prescribing pain medication and proposing rehabilitation strategies. If all non-operative treatments fail, partial or complete wrist denervation might be a successful, although mostly temporary, solution [36–38]. Wrist denervation is a symptomatic treatment and selectively eliminates the anterior and posterior interosseous nerves, which innervate the central two-thirds of the anterior and posterior carpal joint capsule, respectively [39]. Removal of these sensory innervations of the wrist joint provides relief of pain, while maintaining function and mobility of the hand and wrist [39]. Studies report satisfactory results with short

term follow up. One third of the patients need revision surgery at longer follow up duration [36–38]. In addition, several authors state that the degree of pain relief following wrist denervation is inadequate for the patients who perform heavy manual labor [19,38]. Another surgical treatment option for patients following PLD/PLFDs with pain is (partial) arthrodesis [12,19]. Many techniques have been described, including arthroplasty, limited or total fusion, partial or total joint replacement, interpositional arthroplasty and ribcartilage graft implantation [19]. It is important to indicate with physical examination, radiographs and computed tomography, what joints are causing the painful wrist before choosing a technique [19]. Laulan et al. suggest an algorithm for choosing the right treatment on basis of the severity of the scapholunate advanced collapse (SLAC), volar/dorsal intercalated segment instability (VISI/DISI) of the proximal carpal row and patient characteristics [18]. However an arthrodesis may not help all: the patient in our study who received the four-corner arthrodesis remained to have moderate pain [40,41]. Martini et al. stated that the use of a partial arthrodesis is only a temporary solution for treating pain [42]. Following a total wrist arthrodesis a mean VAS of 2/10 combined with 80–90% of normal strength can be expected and most patients are able to return to their previous occupation [18]. In addition, patients rarely perceive the loss of mobility as problematic and patient satisfaction rates range from 80–100% [43].

While local surgical procedures might diminish pain sensation, there is growing evidence that chronic pain is also a determinant of changes in the central nervous system following surgical trauma or nerve injury [44]. The pathophysiological pathway is caused by nociceptive transmission and inflammatory mediators released during surgical procedures [44,45]. In addition, several risk factors for the development of postoperative chronic pain are determined, such as preoperative pain lasting longer than 1 month, psychological vulnerability, worker's compensation and younger age [45]. These risk factors might be applicable to the patients with PLD/PLFDs. Reducing the risk of development of chronic pain can be achieved with good perioperative and postoperative pain management. This results in reduced central sensitization [44]. In addition, managing expectations of patients and careful explanation of surgical procedures and postoperative rehabilitation is known to reduce anxiety and promote recovery [46,47]. It is important, while treating these patients, to be aware of the risk factors for the development of chronic pain and to implement shared-decision making.

Physical functioning. The PLD/PLFD group experienced more problems in daily activities than the control group. The DASH outcomes reported in this study were similar to those described in previous studies in PLD/PLFD patients [9,11]. Capo et al. described worse DASH score, this could be explained by additional upper limb fractures the patients in their study had and the fact that they did not obtain a DASH score for all of their patients [8]. In our study the mean total PRWE score was 31, which was worse than reported in the studies of Forli et al. and Strobel et al. [12,13] The time to surgical treatment was comparable in our study, but the dominant hand was more frequently affected in those studies (44% and 90%) compared to our study (33%) [12,13]. It might be that recovery of an injured dominant hand has a better prognosis, because of its preferred and more intuitive use in daily practice.

Satisfaction. An interesting finding of our study was the poor satisfaction in the PLD/PLFD group. In a *post hoc* exploration of outcomes of the items of the MHQ satisfaction subscale showed that patients were particularly dissatisfied about the range of motion, grip strength, and pain. However, none of these patients sought help for these symptoms. Especially the dissatisfaction about grip strength needs attention in further research, since grip strength measurements did not reveal any differences with control persons. However, comparison of the patients' injured and uninjured side revealed significant lower grip strength in the affected limb, which apparently bothered the participants in their daily life. Until now, satisfaction has not gained attention in literature on PLD/PLFD. As patients nowadays are stimulated to manage their own treatment and be responsible for their recovery as much as possible, patient satisfaction seems to be a relevant topic for future research. Correct briefing of the patients about the eventual outcomes after rehabilitation, including satisfaction issues, may be relevant to improve outcomes in this population. Although the MHQ is mainly developed for patients with rheumatoid arthritis and has not been used in PLD/PLFD patients before, we have shown with the current study that this questionnaire includes relevant topics for these patients [29,30]. The reason for the good applicability of the MHQ is the multidimensionality of the questionnaire, measuring more than just the standard subscales of pain and function.

Overall health status. In addition to diminished injury-specific PROs (pain, physical functioning), patients also experienced diminished general health status in comparison to healthy controls. In literature, only Strobel et al. describe general health outcome measures following PLD/PLFDs using the total SF-36 score (mean 78, SD 23) in patients with mean age of 30 years and after a follow up duration of 67 months [12]. Unfortunately, the subscales of the SF36 are not presented in this study, so no reliable comparison with the results in our study can be made. However, the diminished outcomes in both studies do present an impact of PLD/PLFDs on general health experience. This finding is worrisome and should gain more attention in clinical practice.

Work. Despite pain, lower hand function, less satisfaction and overall diminished experience of general health, the PLD/PLFD patients did not differ from their matched controls regarding work participation. There is no literature reporting validated questionnaires regarding occupation, work participation or work productivity. For further research, it would be interesting to investigate whether sick leave, quality of work and work productivity are also comparable between both groups.

Strengths and weaknesses. The use of a matched control group, two times the size of that of patients is a unique and valuable contribution to present research about PLD/PLFDs. The severity of limitations in pain and physical functioning as experienced by the PLD/PLFD patients can be interpreted in comparison with people of their age and gender. Furthermore, results of a substantial number of validated questionnaires were reported, which are rarely described in literature. The measurements of the CROs were performed by two researchers. This might have created a small measurement bias, even though the author performing the measurements received extensive training from the certified hand therapist. Finally, the biggest challenge of this descriptive cohort study was the scarcity of the injury, which resulted in a small number of PLD/PLFD patients. To achieve respectable research quality, a larger sample size is required by performing prospective multicenter research in the future.

Clinical implications. The study results enable informing PLD/PLFD patients about their expected recovery and outcome. A patient will now know that the flexion/extension and ulnar/radial deviation might remain limited. Informing patients about the expected outcome and providing a patient tailored rehabilitation program is mandatory. Specific attention should be paid to strength rehabilitation of the injured wrist, since we found a significant difference in grip strength between injured and uninjured wrists. Pain, restrictions in daily life function and diminished general health status are likely to be present and patients should be informed about this. It is advisable to use PROs in the rehabilitation program to investigate what implications the PLD/PLFD has on a patient's life and act accordingly. The restrictions patients experience following PLD/PLFDs seem however unlikely to force patients to change their occupation, although individual results show that some minor adjustments at work may be needed. Clinicians need to be alert that pain plays a major role in the life of a PLD/PLFD patient. It is important to recognize risk factors for the development of chronic pain, treat chronic pain when it is present with a combination of optimal pain relieve, shared-decision making and rehabilitation strategies. In addition, partial or complete wrist denervation might be a successful temporary option for patients who do not perform heavy manual labor. Other surgical treatment options include several types of partial or complete wrist arthrodesis. When choosing a type of wrist arthrodesis, it is important to exactly indicate what joints are causing the painful wrist.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

[1] Budoff JE. Treatment of acute lunate and perilunate dislocations. J Hand Surg Am. 2008;33:1424–1432.

[2] Herzberg G. Perilunate and axial carpal dislocations and fracture-dislocations. J Hand Surg Am. 2008;33:1659–1668.

[3] Laporte M, Michot A, Choughri H, et al. Perilunate dislocations and fracture-dislocations of the wrist, a review of 17 cases. Chir Main. 2012;31:62–70.

[4] Cooney WP, Bussey R, Dobyns JH, et al. Difficult wrist fractures. perilunate fracture-dislocations of the wrist. Clin Orthop Relat Res. 1987;(214):136–147.

[5] Inoue G, Imaeda T. Management of trans-scaphoid perilunate dislocations. herbert screw fixation, ligamentous repair and early wrist mobilization. Arch Orthop Trauma Surg. 1997;116:338–340.

[6] Trumble T, Verheyden J. Treatment of isolated perilunate and lunate dislocations with combined dorsal and volar approach and intraosseous cerclage wire. J Hand Surg Am. 2004;29:412–417.

[7] Herzberg G, Comtet JJ, Linscheid RL, et al. Perilunate dislocations and fracture-dislocations: A multicenter study. J Hand Surg Am. 1993;18:768–779.

[8] Capo JT, Corti SJ, Shamian B. Treatment of dorsal perilunate dislocations and fracture-dislocations using a standardized protocol. Hand (New York, N,Y). 2012;7:380–387.

[9] Kim JP, Lee JS, Park MJ. Arthroscopic reduction and percutaneous fixation of perilunate dislocations and fracture-dislocations. Arthroscopy. 2012;28:196–203.e2.

[10] Kremer T, Wendt M, Riedel K, et al. Open reduction for perilunate injuries–clinical outcome and patient satisfaction. J Hand Surg Am. 2010;35:1599–1606.

[11] Lutz M, Arora R, Kammerlander C, et al. Stabilization of perilunate and transscaphoid perilunate fracture-dislocations via a combined palmar and dorsal approach. Orthop Traumatol. 2009;21:442–458.

[12] Strobel U, Tami I, Andreisek G, et al. Comparison of functional results with MRI findings after surgical treatment of transscaphoid perilunate fracture dislocations of the wrist: The role of scapholunate ligament lesions. Handchir Mikrochir Plast Chir. 2014;46:169–176.

[13] Forli A, Courvoisier A, Wimsey S, et al. Perilunate dislocations and transscaphoid perilunate fracture-dislocations: A retrospective study with minimum ten-year follow-up. J Hand Surg Am. 2010;35:62–68.

[14] Changulani M, Okonkwo U, Keswani T, et al. Outcome evaluation measures for wrist and hand: Which one to choose?. Int Orthop. 2008;32:1–6.

[15] Massoud AH, Naam NH. Functional outcome of open reduction of chronic perilunate injuries. J Hand Surg Am. 2012;37:1852–1860.

[16] Garg B, Goyal T, Kotwal PP. Staged reduction of neglected transscaphoid perilunate fracture dislocation: a report of 16 cases. J Orthop Surg Res. 2012;7:19– 17-19.

[17] Marcuzzi A, Leigheb M. Transcapho perilunate dislocation with palmar extrusion of the scaphoid proximal pole. Acta Biomed. 2016;87: 127–130.

[18] Laulan J, Bacle G, de Bodman C, et al. The arthritic wrist. II–the degenerative wrist: Indications for different surgical treatments. Orthop Traumatol Surg Res. 2011;97:S37–S41.

[19] Laulan J, Marteau E, Bacle G. Wrist osteoarthritis. Orthop Traumatol Surg Res. 2015;101:S1–S9.

[20] Watson HK, Ballet FL. The SLAC wrist: Scapholunate advanced collapse pattern of degenerative arthritis. J Hand Surg Am. 1984;9:358–365.

[21] Bradway JK, Amadio PC, Cooney WP. Open reduction and internal fixation of displaced, comminuted intra-articular fractures of the distal end of the radius. J Bone Joint Surg Am. 1989;71:839–847.

[22] ASA House of Delegates. ASA physical status classification system. Washington, USA; 2014.

[23] Lopes J, Grams ST, da Silva EF, et al. Reference equations for handgrip strength: Normative values in young adult and middle-aged subjects. Clin Nutr. 2018;37:914-918.

[24] Veehof MM, Sleegers EJ, van Veldhoven NH, et al. Psychometric qualities of the dutch language version of the disabilities of the arm, shoulder, and hand questionnaire (DASH-DLV). J Hand Ther. 2002;15:347–354.

[25] Van Eck ME, Lameijer CM, El Moumni M. Structural validity of the dutch version of the disability of arm, shoulder and hand questionnaire (DASH-DLV) in adult patients with hand and wrist injuries. BMC Musculoskelet Disord. 2018;19:207.

[26] MacDermid JC, Tottenham V. Responsiveness of the disability of the arm, shoulder, and hand (DASH) and patient-rated wrist/hand evaluation (PRWHE) in evaluating change after hand therapy. J Hand Ther. 2004;17:18–23.

[27] Brink SM, Voskamp EG, Houpt P, et al. Psychometric properties of the patient rated wrist/hand evaluation - dutch language version (PRWH/E-DLV). J Hand Surg Eur Vol. 2009;34:556–557.

[28] El Moumni M, Van Eck ME, Wendt KW, et al. Structural validity of the dutch version of the patient-rated wrist evaluation (PRWE-NL) in patients with hand and wrist injuries. Phys Ther. 2016;96:908–916.
[29] Chung KC, Hamill JB, Walters MR, et al. The michigan hand outcomes questionnaire (MHQ): Assessment of responsiveness to clinical change. Ann Plast Surg. 1999;42:619–622.
[30] Shauver MJ, Chung KC. The michigan hand outcomes questionnaire after 15 years of field trial. Plast Reconstr Surg. 2013;131:779e–787e.
[31] Jenkinson C, Coulter A, Wright L. Short form 36 (SF36) health survey questionnaire: Normative data for adults of working age. Bmj. 1993;306:1437–1440.
[32] Aaronson NK, Muller M, Cohen PD, et al. Translation, validation, and norming of the dutch language version of the SF-36 health survey in community and chronic disease populations. J Clin Epidemiol. 1998;51:1055–1068.
[33] Martinage A, Balaguer T, Chignon-Sicard B, et al. Lebreton E. Perilunate dislocations and fracture-dislocations of the wrist, a review of 14 cases. Chir Main. 2008;27:31–39.
[34] Kapandji IA. Pronatie en suppinatie. In: Bewegingsleer Deel I De bovenste extremiteit. 2nd ed. Houten, the Netherlands: Bohn stafleu van loghum; 2009. p. 100–119.
[35] Leong DP, Teo KK, Rangarajan S, et al. Prognostic value of grip strength: Findings from the prospective urban rural epidemiology (PURE) study. Lancet. 2015;386:266–273.
[36] Milone MT, Klifto CS, Catalano LW. 3rd., Partial wrist denervation: The evidence behind a small fix for big problems. J Hand Surg Am. 2018;43:272–277.
[37] O'Shaughnessy MA, Wagner ER, Berger RA, et al. Buying time: Long-term results of wrist denervation and time to repeat surgery. Hand (New York, NY). 2018; 155894471876003. DOI:10.1177/1558944718760031
[38] Simon E, Zemirline A, Richou J, et al. Complete wrist denervation: A retrospective study of 27 cases with a mean follow-up period of 77 months. Chir Main. 2012; 31:306–310.
[39] Berger RA. Partial denervation of the wrist: A new approach. Tech Hand up Extrem Surg. 1998;2:25–35.
[40] Lamas Gomez C, Proubasta Renart I, Llusa Perez M. Relationship between wrist motion and capitolunate reduction in four-corner arthrodesis. Orthopedics. 2015; 38:e1040–e1045.
[41] Sennwald G, Segmuller G. Arthrodesis of the central support of the carpus. indications, technic, results. Int Orthop. 1989;13:147–152.
[42] Martini AK. Indications and technique of partial arthrodesis of the carpus. Z Orthop Ihre Grenzgeb. 1992;130:175–180.
[43] Weiss AC, Wiedeman G, Jr, Quenzer D, et al. Upper extremity function after wrist arthrodesis. J Hand Surg Am. 1995;20:813–817.
[44] Reddi D, Curran N. Chronic pain after surgery: Pathophysiology, risk factors and prevention. Postgrad Med J. 2014;90:222–227.
[45] Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: Risk factors and prevention. Lancet. 2006;367:1618–1625.
[46] Baars JE, Markus T, Kuipers EJ, et al. Patients' preferences regarding shared decision-making in the treatment of inflammatory bowel disease: Results from a patient-empowerment study. Digestion. 2010;81:113–119.
[47] Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. Lancet. 2003;362:1921–1928.